

Modeling Multiphase Flow of Liquefied Removable Epoxy Foam

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Removable epoxy foam (REF) has been considered for the redesign of engineering systems. A parallel effort has been initiated to understand the material response of this new foam within the Engineering Sciences Center. In this talk, we focus on modeling the flow response of REF as it liquefies. During the pyrolysis of REF, the rigid foam block undergoes phase transition from its structured solid phase to a complex fluid before complete combustion. Vaporization of the fluid phase is favored when the venting path is accessible during decomposition; otherwise, liquefaction and fluid motion dominates the decomposition dynamics.

The thermophysical properties as well as flow properties of REF were almost nonexistent before this project began. A combination of preliminary data and predictive models is used to predict the range of values for fluid viscosity, thermal conductivity, and density. The preliminary flow model consists of a solid and a liquid phase separated by two interfacial boundaries (vapor phase is not explicitly modeled while the fluid-vapor boundary is present). A 2D axisymmetric, cylindrical geometry is assumed, and the resulting problem is solved using the finite-element program GOMA. The interfacial boundaries are controlled by a set of distinguishing conditions driven by the decomposition chemistry and heat flux. Chemical kinetics drive the evolution of liquid and gas-forming components in the liquefied region while an effective mass-transfer coefficient is used to control the rate of evaporation. Since there is a considerable interest in foam behavior under confined geometries, pressure dependency must be accounted for. Experimental and theoretical work to seek a representative vapor-liquid equilibrium mode for REF is also underway.

Concurrent to the modeling effort, experimental data of foam decomposition under radiant heat have been collected. Response of foam decomposition subjected to radiant heat at various heating orientations are recorded via x-ray for model validation. The flow of liquefied foam is most pronounced when heating from the side, where the liquid phase relocates due to gravity. Simulation results for side-heated experiments as well as top-heated experiments are presented and discussed.